BETA
Digital Multimeter

Instruction Manual

GOULD ADVANCE

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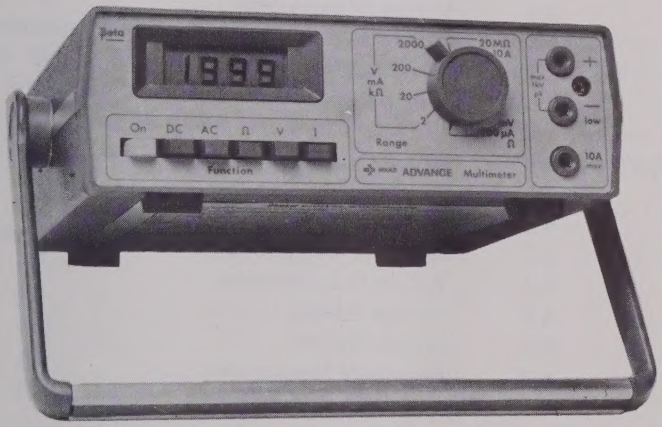
Roebuck Road, Hainault, Essex.
Telephone: 01-500 1000
Telex: 263785
Telegrams: Altenuate Ilford.


Beta
1888
On
DC
AC
Ω
V
I
Function
2000
200
20
2
V
mA
kΩ
20MΩ
10A
Range
mV
µA
Ω
ADVANCE Multimeter
+
low
10A

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ILLUSTRATIONS

Fig. 1	Circuit Diagram. Beta
Fig. 2	Circuit Diagram. Temperature Probe
Fig. 3	Circuit Diagram. RF Probe

Beta introduces a new concept to the 3½ digit general purpose digital multimeter.

It incorporates no less than 29 ranges of AC/DC volts, AC/DC current, resistance and temperature* selected by push buttons for mode and rotary switch for range.

The instrument utilises state of the art CMOS LSI including analogue and digital circuits on one substate and incorporating auto zeroing to eliminate uncertain offset errors. All ranges are protected against overload which is indicated by the display flashing.

The Beta has a minimum number of pre-set resistive trimmers for quick and easy recalibration. The circuit is simple, thereby preserving a high reliability factor with low cost of ownership.

The display uses the latest state of the art liquid crystal display with its unique feature of providing a sharp clear display even in high ambient lighting conditions.

* Option (See Data Sheet and Price List).

DISPLAY – 3½ digit 7 segment Liquid Crystal display with decimal point and polarity indication. Over-range is indicated by flashing the display.

MAXIMUM READING – 1999.

D.C. RANGES

± Range	Accuracy at 23°C			Input Impedance	Resolution	Maximum Overload
	reading		full scale			
200mV	0.2%	±	0.05%	22MΩ	100μV	1kV
2V					1mV	
20V	0.5%	±	0.05%		10mV	
200V				20MΩ	100mV	
1000V					1V	
200μA	1.0%	±	0.05%	Voltage drop 200mV at F.S.D.	100mA	2A fuse protected
2mA					1μA	
20mA					10μA	
200mA					100μA	
2A				≙ 300mV	1mA	
10A	2.0%	±	0.05%	≙ 200mV	10mA	10A

10A range is via separate UNPROTECTED input.

A.C. RANGES

Range	Accuracy at 23°C 40Hz - 2kHz reading	±	40Hz - 2kHz full scale	Accuracy at 23°C 2kHz - 20kHz reading	±	2kHz - 20kHz full scale	Input Impedance typical	Resolution	Maximum Overload
200mV	1.0%	±	0.2%	1.5%	±	1.0%	22MΩ 75pF	100μV	750V to
2V	1.0%	±	0.1%	2.0%	±	0.5%		1mV	2kHz
20V								10mV	350V 2KHz to 20kHz
200V							20MΩ 75pF	100mV	
750V								1V	
200μA	3.0%	±	0.2%				voltage drop 200mV at F.S.D.	100nA	2A fuse protected
2mA								1μA	
20mA								10μA	
200mA								100μA	
2A							≙ 300mV	1mA	
10A							≙ 200mV	10mA	10A

10A range is via separate UNPROTECTED input.

RESISTANCE RANGES

Range	Accuracy at 23°C			Protection	
	reading		full scale		
200 Ω 2kΩ 20kΩ 200kΩ 2MΩ	1.0%	±	0.05%	250V r.m.s.	The open circuit voltage is approximately −2V (+ input is negative with respect to the low input). The short circuit current is < 1.5mA on the 200Ω range.
20MΩ	3.0%	±	0.05%		

Operating Temperature	0 – 50°C
Temperature Coefficients	(typical)
D.C. ranges	0.02% /°C
A.C. ranges	0.05% /°C
Resistance ranges	0.05% /°C
except 20MΩ range	0.1% /°C

Reading Rate.	Approximately 1/sec.
Input Current	typically <10pA at 23° C
Common Mode Rejection:	essentially infinite when battery operated. >90dB when operated from 01B
Series Mode Rejection	>30dB of 50Hz on d.c. range
Power Consumption:	50mW.
Internal d.c. supply:	Four C cells. Or equivalent (see 5.1) typical life on intermittant operation 300 hours.
External d.c. supply:	4 to 15 volts absolute maximum NOTE: This is not isolated from the input (see 3.1)
Dimensions	246mm x 180mm x 72mm
Weight	1.4 Kg.
Accessories Supplied:	Test leads Red PN 33317 Black PN 33318 Handbook Four 'C' cells.

Option 01B — Battery Eliminator

Input 240 volts
Maximum Common Mode voltage, 1000V peak.

Option 02B — Temperature Probe

Range —20°C to + 120°C
Accuracy ± 1°C
Max. temperature + 160°C
Min. temperature —40°C

Option 03B — R.F. Probe with Adaptor

Input resistance > 100kΩ
Input capacitance 3pF
Voltage range 100mV — 30V rms
On-Bias 30mV
Frq. response 20KHz to 500 MHz ± 3dB.

Option 04B — H.V. Probe

1kV to 40 kV 1000: 1 division range
Input resistance 1000MΩ

Option 05B — Carrying Case

To carry Beta Multimeter complete with accessories

3:1 SUPPLIES

The instrument is powered from a battery of four cells housed in the rear of the instrument (for fitting see 5:1). The typical life of HP11 cells is 300 hours when the instrument is used intermittently 4 to 8 hours a day. Remove the exhausted cells from the instrument to prevent corrosion. The battery voltage can be checked by selecting the 20 volts d.c. range and prodding the high input in the rear jack socket to make contact with the outer. The reading will be negative and the batteries should be replaced when the voltage is less than 3 volts.

Alternatively the instrument can be powered with d.c. via the 6mm battery jack socket at the rear; option 01B should be used. If a separate external d.c. supply is used, the voltage must be $> 4V$ and $< 15V$. NOTE: The positive of the supply is connected via a diode to the low of the instrument input.

Connect the supply, positive to tip, negative to ring.

3:2 DISPLAY

The display has a maximum reading of 1999 with decimal points selected automatically. If the reading exceeds 1999 the display 'flashes 999'. When on d.c. ranges, the polarity of the input is automatically indicated by the + or – sign.

3:3 VOLTAGE MEASUREMENTS

Select the appropriate Function, D.C. or A.C., also the voltage button, V. Now select the required range on the rotary range switch. Apply the input to the sockets labelled + and – (low). It is advisable where possible to connect the low input to the lowest impedance with respect to supply ground, this will reduce common mode voltages. When measuring high voltages, care should be taken to observe the maximum input and common mode voltages.

To measure a voltage above 1KV the H.V. probe (Option 04B) is available. For r.f. voltage measurements use the probe (option 03B) with the B.N.C. to 4mm adaptor. (see fig. 3).

3:4 CURRENT MEASUREMENTS

Select the appropriate Function, D.C. or A.C., also the current button I. Now select the required range on the rotary range switch. Apply the input to the + and – (low) sockets for ranges up to 2A. For the 10A range, connect the high input to the separate 10A terminal. The maximum continuous overload is 2A and fuse, FS1, provides protection for sustained overloads in excess of this current. The 10A range is not protected.

3:5 RESISTANCE MEASUREMENTS

Select the function button, Ω, and the appropriate range with the rotary range switch. Connect the resistance to be measured between the + and – (low) socket. The internal current source for measurement gives a negative voltage at the + socket. The input is protected up to 250V r.m.s. on all ranges.

3:6 TEMPERATURE MEASUREMENTS

Switch off instrument and connect probe unit to input sockets and power pack. Select 2v d.c. range and switch on.

Apply probe to a known reference temperature and adjust potentiometer (accessible through hole in side of probe adaptor box) until instrument indicates appropriate reading.

Reference may be room temperature if known, or melting ice (0°C) or normal body temperature (37°C).

The reading on the Beta must be multiplied by 100 to give temperature in °C.

4:1 POWER SUPPLY

The battery, B1-B4, is connected to the d.c. converter.

The oscillator formed by TR3, C13 and T1, is controlled by TR2, and overall regulation is provided by the feedback through D13. The outputs of T1 are rectified and smoothed to give +6V, –6V and +13V. The instrument can be powered from an external d.c. supply via SKB using a battery jack, which disconnects the internal battery.

4:2 DISPLAY

The liquid crystal display is driven by IC's4, 5 and 6, which are B.C.D. to seven segment drivers and IC3, a four segment driver.

The gates, IC8c and IC8d, are connected as an astable multivibrator. The output from IC8d Pin 11 is used as the phase drive and the opposite phase output from IC8c, pin 10 is selected by S7aF to drive the appropriate decimal point. IC7b toggles at the reading rate when the range is exceeded and pin 12 is connected to the display blanking inputs on IC's4, 5 and 6. giving a 999 'flashing' display for over-range.

4:3 ANALOGUE TO DIGITAL CONVERSION

The analogue to digital conversion is performed by IC2. IC2 uses the dual slope integration method. It also provides high input impedance, zero correction both analogue and digital, automatic polarity selection and latched digital readout.

The unknown voltage is applied to pin 3 and the reference voltage to pin 2, (200mV for the 200mV and current ranges and 2V for all other ranges). R34, R48 and C9 are the integration components, C10 the zero correction storage capacitor and R36 sets the internal clock oscillator frequency. The digital output is multiplexed B.C.D. and the 4 digit-select outputs identify the correct information to load the latches in the display drivers IC's 3, 4, 5 and 6. The reading rate is controlled by delaying the display up-date input to IC2 pin 9. The inverted end of conversion signal clocks the input of IC7a and the toggle rate is set by R35 and C11 which are connected to the data input of IC7a pin 5.

4:4 A.C. to D.C. CONVERTER

A.C. input voltages are converted to d.c. by the operational amplifier, IC1 and associated components. TR6 provides a high input impedance and R13, D5 and D19, protection. The rectified outputs from D6 and D7 are re-combined in R19 and R22 to reform the a.c. waveform which is coupled as feedback by C5. The d.c. working point of IC1 is controlled by the feedback through R15. The half wave rectified output is taken from D6 and filtered by R17 and C6 to be measured as d.c.

4:5 VOLTAGE RANGES

The input voltage is applied directly to IC2 or TR6 on the 200mV and 2V ranges. R23 and C2 provide input filtering and D9 and D10 are protection diodes. For the 20V, 200V and 1kV ranges the input is attenuated by R7 and R8, R9 or R10. The attenuator resistors are compensated by C17 to C20, and C27 to C30 for the higher frequency a.c. operation.

4:6 CURRENT RANGES

Current inputs are measured using the 200mV range on a.c. or d.c. to monitor the voltage developed across the shunt resistors, R1 to R6. Diodes, D1 to D4, protect the shunts by limiting the voltage across them, the fuse FS1 will blow if the current exceeds 2A. The 10A shunt is connected directly to a separate terminal and is not protected.

4:7 RESISTANCE MEASUREMENT

Resistance is measured ratiometrically by applying a voltage across a reference resistor and the unknown resistor in series, then integrating the voltage across the unknown and comparing it with the voltage across the reference resistor. A voltage defined by D18 is applied to the reference resistor and the voltage reference input of IC2 pin 2. The junction of the reference resistor and the unknown resistor is connected to analogue ground IC2 pin 1. The unknown resistor is then connected to the voltage input IC2 pin 3 and held to approximately 0V by TR1. The voltage across the unknown is compared with the voltage across the range reference resistor R7 to R12. D8, D11 and D12 are protection diodes.

4:8 TEMPERATURE MEASUREMENT

Temperature measurements are made by using the change with temperature of the emitter-base voltage of a transistor mounted in the tip of the probe unit. The transistor also functions as an amplifier and the collector voltage is read on the 2v d.c. range of the instrument. The base circuit is fed from a constant voltage obtained from resistors R6 and R7 connected across Zener diode D1. (See circuit diagram, Fig. 2.) The base resistor R8 is selected to suit the gain of the transistor. Final calibration is provided by the selection of R10 using measurements at three spot temperatures.

The probe must be set to a known reference temperature for use with a particular instrument. (See paragraph 3:6). Bias is adjusted accordingly by R2 increased, if required, by R4.

5:1 BATTERY REPLACEMENT

Switch off the instrument. Remove the rear panel by rotating the two captive screws 1¼ turns. Lever out the four exhausted cells and replace with new cells observing the polarity then replace the rear cover.

The following cells are suitable equivalents but will not have an equivalent working life.

BRITISH STANDARD – HP11, I.E.C. – R14. AUSTRIA – R14A. BELGIUM – E9. DENMARK – 727. FRANCE – R14L. P14. GERMANY – 235LP. 259. U.K. – HP11, SP11, MN1400, HC1. HOLLAND – 614. ITALY – AC11. JAPAN – UM2D (HITOP) N139 (UM2 (T)). NORWAY - 235. SINGAPORE – 835.

5:2 DISMANTLING THE INSTRUMENT

Switch off the instrument and remove the rear panel sec. 5:1. Remove the four screws in the corners of the rear mouldings and withdraw the complete assembly from the case. To re-assemble, align the switch shaft key approximately with the key way in the front panel mechanism. Slide the assembly into the case, rotate switch knob until the shaft locates, and the display bezel enters the front panel. Replace the four screws in the rear. If the instrument is to be operated while out of the case extreme care must be taken to ensure the rotary switch is in the correct position.

5:3 FUSE REPLACEMENT

To replace the current protection fuse, FS1, remove the instrument from the case (see 5:2) The fuse is located on the main board between the rotary and push button switches, replace with a 2A, 20mm x 5mm fuse.

5:4 RECALIBRATION

To recalibrate, the instrument must be removed from the case, therefore all ranges must be selected before applying an input. To select a range align the switch shaft key with mask on the front printed circuit board also use the decimal point to identify it and by inspection ensure that the rotor is in the centre of the switch tag on the front wafer.

RECALIBRATION SEQUENCE

Function	Range	Input	Set
DC	2V	+1.900V	R29
DC	200mV	+190.0mV	R32
AC	2V	1.900V @ 600 Hz	R22
AC	200V	190V @ 20kHz	C27
AC	20V	19V @ 20kHz	C28

NOTE: If components are changed it may be necessary to select associated 'Adjust on Test' components.

5:5 FAULT LOCATION

No display on one or more digits, Check:—

(1) Battery voltage with a separate meter.
(2) Power Supply rails +6V and —6V to ± 0.7V
(3) Oscillator Output from IC8c pin 10.
(4) Blanking output of IC7b pin 12 is low.
(5) IC2 B.C.D. and Digit Outputs.
(6) IC3, IC4, IC5, IC6.
(7) Display and socket.

No measurement on 2V range d.c. Apply 1 to 2 volts and check:—

(1) Input wiring and switch path to IC2 pin 3.
(2) Power supplies at IC2 pins 12, 13 and 24.
(3) V ref. to IC2 pin 2.
(4) Clock at IC2 pin 11.
(5) Output from IC2 pin 14 through TR7 and IC7a to IC2 pin 9.
(6) Digit lines, IC2 pins 16, 17, 18, 19
(7) B.C.D. Outputs IC2 pins 20, 21, 22 and 23.

No measurement on a.c. ranges.

Select 2V a.c. range and apply 1—2V approx. 1KHz check:—

(1) Input to TR6.
(2) Output IC1 pin 6 d.c. level 2.2V
(3) Supplies IC1 pin 7, 8.
(4) Half wave output at junction R17 and R18.

No measurement on 20V, 200V, 1000V a.c. or d.c. ranges.

Check the input switching and attenuator.

No measurement on d.c. and a.c. current ranges check:—

(1) FS1
(2) Input switching
(3) R1—5

No measurement on ohms ranges. Select the 2KΩ range and connect 1—2KΩ across the input.

(1) Input switching and range switching.
(2) V ref at junction R7 to R12.
(3) TR1 (c) voltage.
(4) R24.

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	½W	10%	unless otherwise stated
CF	Carbon Film	1/8W	5%	unless otherwise stated
MO	Metal Oxide	½W	2%	unless otherwise stated
MF	Metal Film	¼W	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer		20%	unless otherwise stated
PCP	Preset Potentiometer Type MPD, PC		20%	unless otherwise stated

CAPACITORS

CE(1)	Ceramic		+ 80% – 25%	
CE(2)	Ceramic	500V	± 10%	unless otherwise stated
SM	Silver Mica			
PF	Plastic Film		± 10%	unless otherwise stated
PS	Polystyrene			
PE	Polyester		± 10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (aluminium)		+ 50% – 10%	
T	Tantalum		+ 50% – 10%	

CIRCUIT COMPONENT LIST FOR BETA

Item	Circuit Ref.	Description	Value	Tolerance%	Rating	Remarks	Part No.
	R1	MF	900	±1			36829
	R2	MF	90	±1			36830
	R3	WW	9	±1			36831
	R4	WW	0.9	±1			36832
	R5	WW	0.1	±1			36833
	R6	Current Shunt	.01			Current Shunt	A3/36783
	R7	WW	20M	±0.25		2 x 10M 1%	36834
	R8	MF	2M22	±0.25			36835
	R9	MF	202k	±0.25			36836
	R10	MF	20K	±0.25			36837
	R11	MF	200	±0.25			36839
	R12	MF	2k	±0.25			36838
	R13	CF	270k		2W		36840
	R14	CF	100k	±5	1/8W		21819
	R15	CF	10M	±5	1/8W		32661
	R16	CF	470k	±5	1/8W		32330
	R17	CF	1M	±5	1/8W		31840
	R18	MF	4k7	±1			29356
	R19	MF	2k	±1			22622
	R20	CF	100Ω	±5	1/8W		21794
	R21	CF	100Ω	±5	1/8W		21794
	R22	PCP	250				29371
	R23	CF	470k		2W		36841
	R24	CF	4k7	±5	1/8W		21805
	R25	CF	33k	±5	1/8W		21814
	R26	CF	10k	±5	1/8W		21809
	R27	MO					A.O.T.
	R28	MF	30k	±1			36973
	R29	CP	2k5				28969
	R30	MF	14k	±1			36974
	R31	MF	1k	±1			36975
	R32	CP	250				29371
	R33	CF	2k2	±5	1/8W		21802
	R34	CF	330k	±5	1/8W		32357
	R35	CF	560k	±5	1/8W		32359
	R36	CF	180k	±5	1/8W		21822
	R37	CF	22k	±5	1/8W		21812
	R38	CF	1M	±5	1/8W		31840
	R39	CF	1M	±5	1/8W		31840
	R40	CF	1M	±5	1/8W		31840

Item	Circuit Ref.	Description	Value	Tolerance%	Rating	Remarks	Part No.
	R41	CF	1M	±5	1/8W		31840
	R42	MO	27k	±2			28808
	R43	CF	100k	±5	1/8W		21819
	R44	CF	1M	±5	1/8W		31840
	R45	CF	100k	±5	1/8W		
	R46	CF	10k	±5	1/8W		21809
	R47	CF	1k2	±5	1/8W		21800
	R48	CF	56k				28729
	R49	CF	10M				32661
	R50	MO	10k				28800
	C1	PE	±01μF		400V		31388
	C2	CE(2)	.1μF				19647
	C4	T	10μF		35V		35931
	C5	CE(1)	.1μF				19647
	C6	PE	.1μF				31377
	C7	PE	.1μF				31377
	C9	PE	.01μF				31377
	C10	CE(1)	.1μF				19647
	C11	T	.1μF		35V		34895
	C12	CE(1)	.1μF				19647
	C13	CE(2)	10.000pF		500V	Erie W5R	31754
	C14	T	100μF		10V		53571
	C15	T	100μF		10V		53571
	C16	T	22μF		35V		35932
	C17	CE(2)	5pF		1kV		34360
	C18	SM	68pF				34353
	C19	PS	1000pF				35918
	C20	PS	.01μF				35924
	C21	CE(1)	.1μF				19647
	C23	CE(1)	.1μF				19647
	C24	T	4.7μF		35V		53249
	C25	PS	.1000pf				35918
	C26	T	6.8p μF		25V		32685
	C27	Trimmer	6pF				29421
	C28	Trimmer	10pF				32669
	C29	PS	270pF			A.O.T.	
	C30	PS	2000pF			A.O.T.	
	TR1	BD 159					34652
	TR2	2N 3906					21533
	TR3	ZTX 450					36701
	TR4						A37101
	TR5	2N3904					24146
	TR6	BF 244B					36846
	TR7	2N3904					24146
	TR8	BF244A					36354

Item	Circuit Ref.	Description	Value	Tolerance %	Rating	Remarks	Part No.
	D1	IN 5402					51382
	D2	IN 5402					51382
	D3	IN 5402					51382
	D4	IN 5402					51382
	D5	IN 3595					29330
	D6	IN 4148					23802
	D7	IN 4148					23802
	D8	IN 4007					52337
	D9	IN 3595					29330
	D10	IN 3595					29330
	D11	IN 3595					29330
	D12	IN 3595					29330
	D13	Zener	13V				33938
	D14	IN 4148					23802
	D15	IN 4148					23802
	D16	IN 4148					23802
	D17						
	D18	Zener	5VI				33928
	D19	IN 3595					29330
	D20	IN 4148					23802
	D21	IN 4148					23802
	D22	IN 3595					29330
	IC1	3476					36721
	IC2	MC14433					36842
	IC3	CD4054					36843
	IC4	MC14543					36844
	IC5	MC14543					36844
	IC6	MC14543					36844
	IC7	4013					34954
	IC8	4001					36195
	LCD1	SLC1013					A3/36848
	T1						36924
	S1-S6						A3/36798
	S7a						A4/36801
	S7b						A4/36802
	FS1				2A		32340
	SKA						A4/36943
	SKB						A4/36792

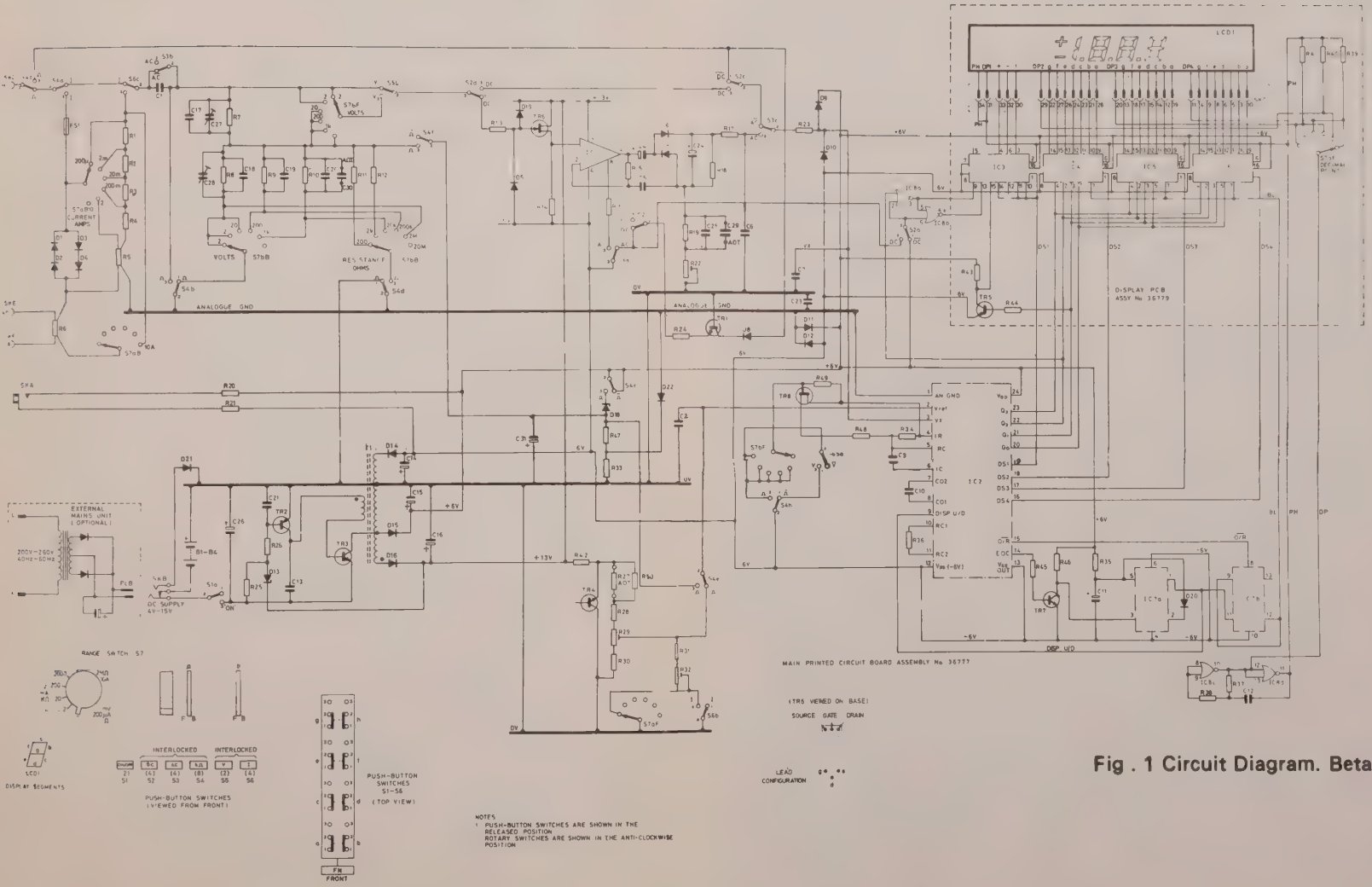

Fig . 1 Circuit Diagram. Beta

Item	Circuit Ref.	Description	Value	Tolerance %	Rating	Remarks	Part No.
	R1	CF	3K3				21803
	R2	PCP	2K2			Preset	25362
	R3	CF	10K				21809
	R4	CF	10K			A.O.T.	
	R5	CF	15K				28727
	R6	CF	27K				21815
	R7	CF	3K3				21803
	R8	CF	5K6			A.O.T.	
	R9	CF	2K7				28726
	R10	CF	6K8			A.O.T.	
	D1	Zener	6.8V				33931
	TR1					Chip W leads	37318
	PLA	2.5mm Dia. jack					A4/36770
	PLB	4mm Dia. plug					A4/37438

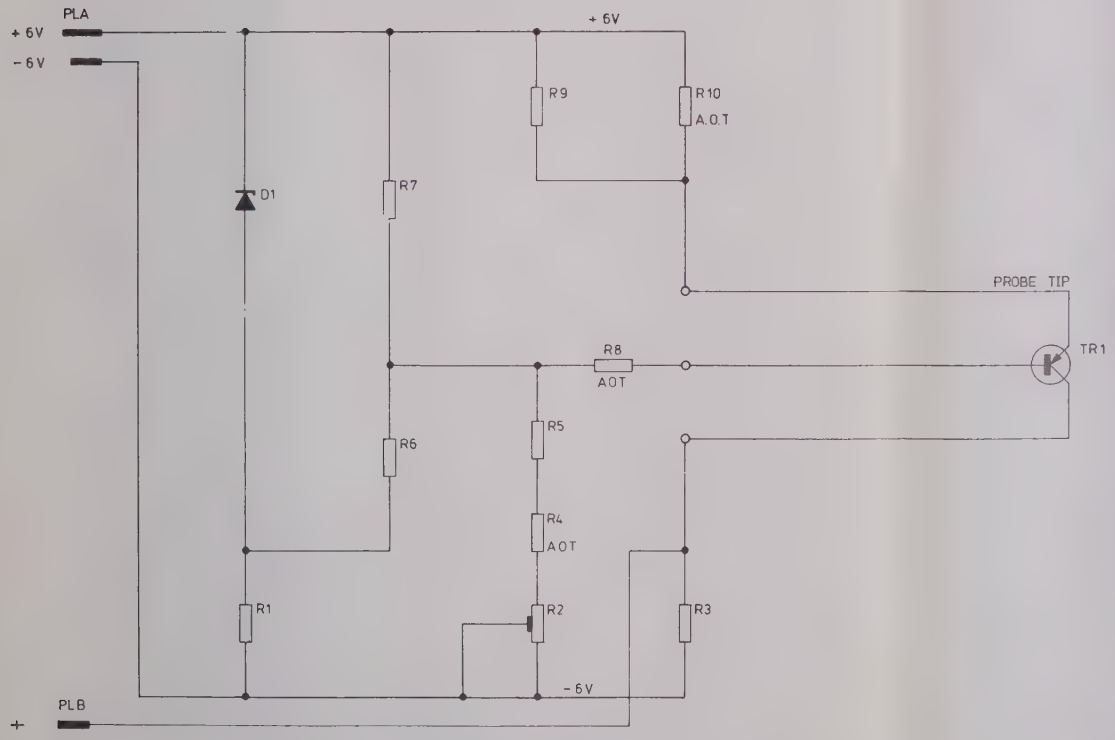

Fig. 2 Circuit Diagram. Temperature Probe

Item	Circuit Ref.	Description	Value	Tolerance %	Rating	Remarks	Part No.
	R2	CF	10KΩ	5	1/8W		21809
	R3	PCP	8K2	5	1/8W		21808
	R4	CF	250Ω				35895
	R5	CF	1K	5	1/8W		A.O.T.
	R6	CC	6M8	10	1/8W		37320
	C3	PE	1.0μF	10	100		31364
	D2	Diode AAZ15					4472
	D3	Diode AAZ13					4472
	PB–	RF Probe Assy					37319
	PLA	2.5mm Dia jack					A4/36770
	PLB	4mm Dia. plug					A4/37438

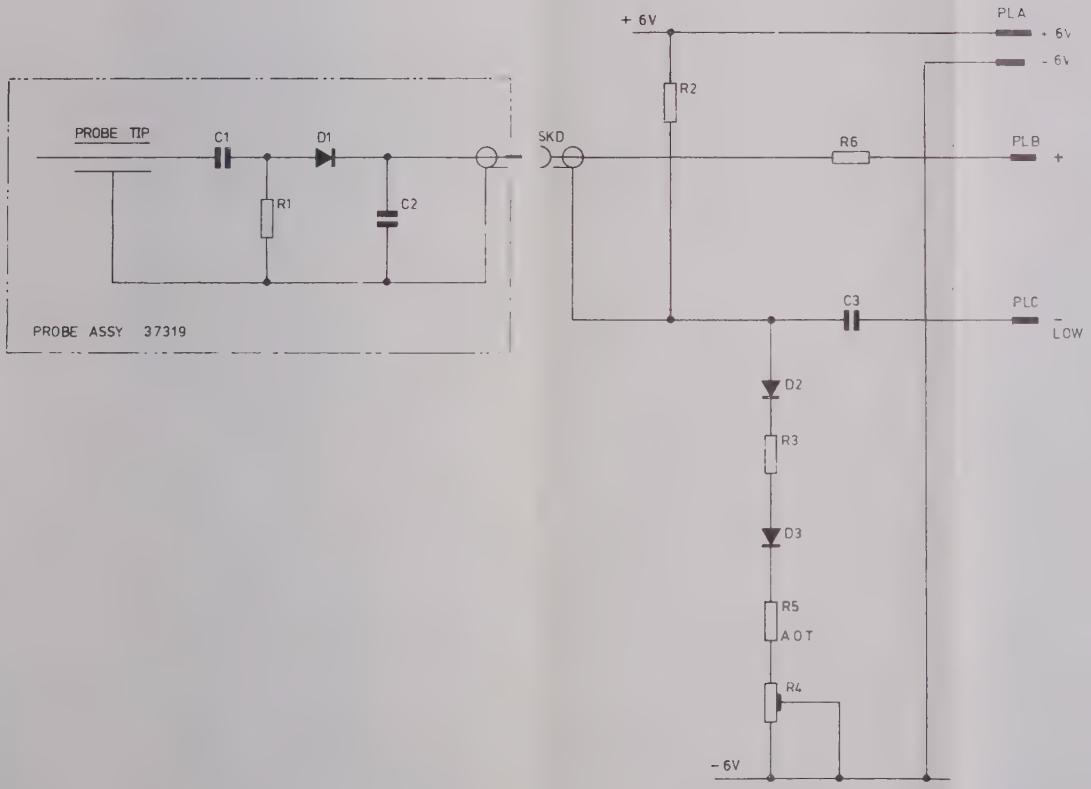

Fig. 3 Circuit Diagram. RF Probe

Guarantee and Service Facilities

Section7

This instrument is guaranteed for a period of two year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The type and serial number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other instructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

Service Dept.
Roebuck Road,
Hainault,
Essex.

Tel: 01-500 1000

Manual Part Numer 37027

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